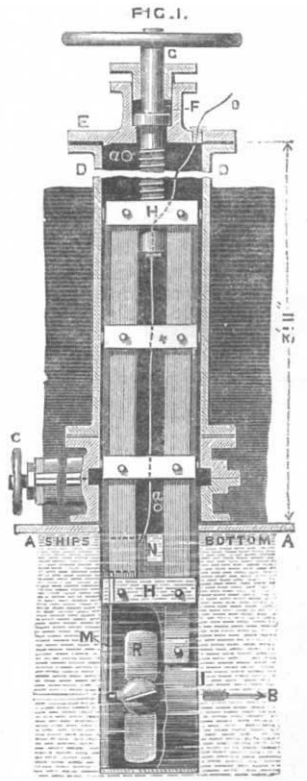
end, which is conical, a rope is fastened, so as to enable the log to be towed by the ship. A modification of this is called the "detached" log, the revolving fan and case for the clockwork being two separate pieces. To both these logs there are several objections, such as the almost unavoidable entrance of salt water to the wheelwork, the drag on the ship, which is often as much as 40 lbs. or more, the inconvenience of hauling in the log each time it has to be read, and lastly, the loss of the whole instrument, should the towing-line break.

To obviate these objections, the taffrail log was invented, and which goes a step further than the detached log, by taking away the recording portion to the taffrail of the ship, and causing the towing rope to transmit the revolutions of the fan to it. These logs are, in many respects, a great improvement on the first; the registering dial is less liable to damage, and is always visible; the tension of the towing line is less; it is therefore less liable to rupture, and even when this does take place, the fan is

FIG. 1.



easily replaced. On the other hand, the unsuitable nature of the towing line for transmitting torsional force, is obvious. Further, the slip of the fan must by seriously affected by the constant variation, in length, of the submerged portion of the line. In Walker's log these difficulties are partly met by the use of a governor, consisting of a pair of weights fixed to the towing line, and revolving with it; but this device can only modify the evil.

The late Mr. W. Froude, who pointed out other objections to existing logs, endeavoured for some time to devise an electrical log, in which the revolutions of an accurately formed screw should be communicated to the deck, *not* by the revolution of the towing rope, but by an electric current in wires carried by it. Eventually he succeeded, in conjunction with Mr. Brunel, in constructing an instrument of this kind, which was applied to Sir W. Thomson's yacht, *Lalla Rookh*, and worked very well, till by some mischance, it carried away and was lost. Mr. Kelway had, meanwhile, been working independently with the same end in view, and had constructed an electric log, which he brought before the notice of the Admiralty. A trial of this last instrument was undertaken by Messrs. Froude and Brunel, on board H.M.S. *Shah*. In this trial, the registering portion was placed on the poop, and self-recording apparatus was used, by which at every revolution of the fan a pen was lifted from a strip of paper moved by clockwork, thus causing breaks in the otherwise continuous line. On a line parallel to this, time in half seconds was simultaneously recorded. The result of this trial was to clearly demonstrate the satisfactory action of Mr. Kelway's log, and it was afterwards applied, together with accurately formed fans, to H.M.S. *Iris*, and the yacht *Alberta*. Its further extension has not been proceeded with, apparently in consequence of Mr. Froude's decease. Quite recently the same inventor has put into practice the happy idea of placing the electrical log to work altogether under the ship's bottom. The way in which this is done is shown (Fig. 1). A water-tight case is securely fixed to the bottom plates (AA), in this case a frame (HH) is moved up and down, and in the lower part of the frame the fan (R) works. The fan communicates its motion by a vertical spindle (M) to a box (N), in which electric contact is made and broken eight times in a mile. The wire (OO) can thus transmit a record of the distance passed over to a dial or dials fixed in any part of the ship.

This invention has the advantage of allowing the screw of the instrument to work in water of uniform pressure, and to a great extent free from the disturbing action of the waves. There is undoubtedly a body of water carried along by the surface friction of the ship. The depth to which this extends is unknown, but there is strong reason to think it is very small, and would not therefore affect the fan. The log itself, however, offers an excellent opportunity of investigating this obscure point, since it can easily be raised or lowered to different positions.

The complete instrument is at present being exhibited at the Crystal Palace Electrical Exhibition, and an account of its various applications has been recently given in a paper by Mr. Kelway. These applications are many and important, and the invention, besides being very suitable for its original purpose, promises to afford valuable information, not to be obtained by the use of ordinary logs. H. S. H. S.

THE TONNAGE QUESTION

ONE of the most interesting papers discussed at the recent meeting of the Institution of Naval Architects was on the Revision of the Tonnage Laws. The author, Mr. W. H. White, is, from his position as Chief Constructor at the Admiralty, as well as from his well-known attainments, a singularly impartial and able judge of this most difficult question. The occasion which called forth the paper was the report on the tonnage question lately issued by the Royal Commission, which last year took evidence on this subject. The report was, as is well known, not signed by all the commissioners. Two of them, viz. Mr. B. Waymouth, Secretary to Lloyd's Register, and Mr. Rothery, Q.C., the Wreck Commissioner, wrote independent reports, which differed widely from that of the majority, and from each other.

The state of the Tonnage Laws has for a long time past given rise to serious complaints, on various grounds. As matters stand at present it is possible for a steamer not only to have no tonnage at all, but even, as is the case of a vessel well known on the Clyde to have a negative tonnage. It is also alleged that the indiscriminate measurement of all inclosed spaces on deck for tonnage has a direct tendency to produce unsafe vessels, by taxing the covering in of the large open spaces above the engine, &c., and also by unduly taxing vessels provided with hurricane decks, which, from their nature, can never be entirely filled with cargo.

Mr. White, in his paper, reviews the whole question historically. He begins by propounding the question, should *internal capacity* be still retained as the basis of measurement, regard being had to the present conditions of trade and shipping? He shows that some of the earliest tonnage laws on record had this basis, such for instance as the French Ordonnance de la Marine of 1681, and the English law of 1720. The vessels to which these laws applied were mostly engaged in the wine and spirit trade, and the measure of 42 cubic feet to the ton, which was the basis of the law of 1681, very approximately expressed the dead-weight capability of the ship as well; for 42 cubic feet were allowed for stowing four bariques of wine, which weighed approximately one ton. Thus the vessels measured by this rule were enabled very approximately to carry as many 20 cwt. tons as they contained tons of cubic capacity. The principle of measurement by internal capacity, as now accepted, was not adopted till the year 1833. In 1836 the New Measurement Law, proceeding on these lines, was passed, and in 1854 came the more perfect Merchant Shipping Act of Moorsom. In framing this law, two fundamental conditions were accepted :—

First, that the taxable tonnage of a ship should be represented by her freight-earning power.

Second, that the space available for the conveyance of passengers and cargo should be taken as the measure of freight-earning power.

The great question of the moment is, whether the changes in the construction and propulsion of ships made since 1854 have not necessitated some modification of the doctrine that internal capacity is the fairest measure of the possible earnings of most ships. Mr. White thinks that this is scarcely a matter for argument, it being generally admitted that in the great majority of ships of the present time, the limit of freight-earning is the dead-weight capability. He points to the awning deck class as a case in point. "It undoubtedly has much to recommend it as regards safety and good behaviour; yet it appears that the internal capacity is so great in proportion to the carrying-power, that the whole available space can never be utilised, even when the lightest cargoes are carried."

In support of this view Mr. Waymouth stated that the "aim of the ordinary ship-owner is to have a vessel which will carry as many 20 cwt. tons upon as few 100 cubic feet tons (on which he pays his tonnage dues) as he possibly can." It is, as Mr. White points out, perfectly obvious that the number of 20 cwt. tons in a given ship depends upon the load-line, and that consequently there is a close connection between tonnage legislation and load-line rules, so much so, that contrary to the opinion of the majority of the Commission, the two questions should be considered together.

The majority of the members of the Royal Commission were averse to any change in the present principle of measurement by internal capacity, for reasons which are stated at length in their report, and which are nearly all founded upon the inconvenience which would result from any change to foreign countries which have copied our Tonnage Laws, and to the various port and dock authorities throughout the world. Though averse to any change in principle, they yet recommended certain amendments to the existing law, which related chiefly to the deductions which should be allowed from the gross tonnage, and also as to the mode of measuring the tonnage of iron ships, particularly of those having cellular double bottoms. Regarding the deductions from gross tonnage, it is to be noted that no provision has been made for the case of awning-decked vessels. Also the Committee was of opinion "that the exemption of any closed-in space from measurement into tonnage, as an inducement to owners to increase the safety of ships is unsound in principle, and if adopted would have to be followed by new restrictions, upon which fresh complaints would be founded." This is an alternative which in our opinion is preferable to continuing regulations which admittedly discourage the building of safe types of ships.

The proposals of the Commission as to the measurement of the tonnage space of cellular double-bottomed ships appears to us to err in the same direction. If their recommendation were carried out, part of the space between the double bottoms would actually be included in the space available for tonnage measurement. Now it is absolutely impossible to carry freight between the double bottoms, and on the other hand, vessels built on this system are the strongest afloat; consequently the recommendation is not only a violation of the principle of the Act of 1854, but also unfairly handicaps this excellent type of ship.

It will thus be seen that the majority of the Royal Commission recommend that things should be left as they are, subject to certain amendments in detail, some of which latter appear to be wrong in principle, and are moreover unpopular with both builders and owners.

The alternative proposal made by Mr. Waymouth was that dead-weight capacity should be adopted as the basis of measurement. His proposals are summarised in the following words :—

"I propose that the total dead-weight carrying capability of a vessel should be ascertained, and also the line to which she is immersed when equipped ready for sea, without cargo on board. In the case of a sailing vessel there should be no consumable stores on board, and similarly in a steam vessel, the engines should be complete, and the boilers full of water, but there should be no coals on board. Under these conditions it is considered that steamers would be in a relatively fair position, one against another, and also in relation to sailing vessels.

"The dead-weight required to immerse a vessel from the light line to a maximum load line fixed by authority, would denote her utmost carrying capability (in tons of 20 cwt.), compatible with safety in ordinary circumstances.

"There is a growing disposition, on the part of ship-owners, to regard with favour the fixing of such load line, provided that the authority on whom the duty would devolve be so constituted as to inspire confidence in its decisions."

Mr. Waymouth's proposal would, if adopted at once get rid of an enormous mass of difficulties. On the other hand, the fixing of a load-line would be certain to give rise to numerous disputes, and moreover, though doubtless applicable to the majority of merchant steamers, the dead-weight system would not apply to passenger steamers.

Mr. Rothery's proposal was of quite a different nature. It is at least open to doubt if the principle of the Act of 1854, viz. that the freight-earning capability of the vessel should be the basis on which to assess her taxable tonnage, is correct. It is not by any means clear that there should be any connection whatever between the two. There is another principle which has much to commend it from the common-sense point of view, viz. that the service rendered to the vessel by the institution to which she has to pay, should be the basis on which to calculate the payment. This is the view adopted by Mr. Rothery in his report. Now, in the case of a dock or port, the service rendered to a vessel for accommodation is proportional to the space which she occupies in the water, and to the length of time which she occupies it. The exact space occupied by a vessel in the water is proportional to her displacement, and hence Mr. Rothery proposes to adopt the system of displacement tonnage.

Mr. White does not enunciate any views of his own as to the best basis on which to assess the dues, in the event of a revision of the present law. It is not, however, difficult to perceive that he favours the principle of

service rendered to the vessel, and not the freight-earning power as the basis of assessment. Mr. White differs, however, from Mr. Rothery in the mode in which the space occupied by the vessel should be measured. He considers that for all practical purposes this space is equal to the parallelopipedon formed by the extreme length, extreme breadth, and the mean draught, and consequently thinks that "parallelopipedon tonnage," as it is called, has much to recommend it. The possibility of berthing other vessels at the same dock or wharf is not sensibly altered by the under-water shape, consequently the above seems a fair measure of service rendered.

Mr. White does not consider that the above proposal would lead to the adoption of a box-shaped type of vessel. He thinks that the cost of propulsion of a steamer would effectually check any such tendency.

Mr. White concludes his most able paper by the following piece of advice, which we trust may be taken to heart by whatever government finally undertakes to revise the tonnage laws.

"In conclusion, I would venture one remark respecting the course of procedure which promises to give the best results, if a revision of the tonnage law is decided upon. Valuable as the labours of committees and commissions may be in testing the feeling of those interested in shipping, and putting on record the opinions of competent authorities who view the subject from different standpoints, it does not appear that a satisfactory revision can be looked for in this direction. The precedent to be found in the preparation of the law of 1854 seems to be a good one. Following after the work of the commissions came the careful, extensive, and laborious inquiry of Moorsom, a scientific expert, having a thorough acquaintance with the subject, and placed in direct communication with the shipping community. If the long-talked-of Central Council or Advisory Board should be constituted to deal with matters relating to the mercantile marine, and if it should be assisted by a competent scientific staff of naval architects, we may hope that, among other much-needed action, will be included the revision of the tonnage laws in a sense that will give more general satisfaction than could otherwise be obtained."

THE NAVAL AND MARINE ENGINEERING EXHIBITION

THE Exhibition which Mr. Samson Barnett, jun., has opened at the Agricultural Hall, and which closes to-day, contains a very large number of objects connected directly and indirectly, and sometimes even totally disconnected with naval purposes. The collection is by no means totally devoid of novelties and of objects of considerable scientific interest. The Exhibition contains numerous models of recently-built war and merchant ships, a few small marine engines and boilers, and portions of large-size marine boilers, together with fittings of engines and boilers in great variety. There are also several specimens of steam steering gear, ships' telegraphs, steam capstans, cranes, and machinery generally for loading and unloading vessels, boat-lowering apparatus, life-saving appliances, dredging gear, and refrigerating appliances. Naval artillery was not well represented, but Messrs. Hotchkins and Co. exhibited some fine specimens of their beautiful revolving cannon, which have been adopted in the navies of several foreign governments, notably in those of France, Germany, Russia, and Italy.

The ships' models are as a rule very deficient in interest, in spite of the fact that they represent many of the most famous of modern vessels, such as the *Devastation* and *Polyphemus*, among men-of-war, and the *Servia*, the *City of Rome*, and the *Ravenna* amongst passenger steamers; for they were mostly half models of the outsides of the vessels, which, though they give a very good idea of the exterior form, afford no information as to the construction, the interior arrangements, or the engines and boilers. This is somewhat disappointing when we remember what strides have been made in recent years in the construction of iron ships.

In the Department of Marine Engines and Boilers there was a remarkable absence of models, or even of drawings of the very fine engines with which our first-class war and merchant steamers are now fitted. By far the most important objects exhibited in this section were the magnificent flanged front plates of boilers, one of these being fifteen feet in diameter, and made in a single piece, with three flanged openings for furnaces, from a single 3-ton ingot of Siemens' steel. The same firm also exhibited several specimens of Fox's corrugated furnaces, an invention which has conferred the greatest benefits on the cause of steam navigation, by rendering possible the use of the very high boiler-pressures which are so essential to economy of fuel. Mr. David Joy also showed a model of his own celebrated valve-gear, which has given such excellent results with locomotives at Crewe, and which will doubtless soon become favourably known to marine engineers. This valve-gear is probably the most serious competitor to the old link-motion driven by eccentrics, first adopted by Stephenson for locomotives, and which has remained in pretty general use up to the present time. Mr. Joy's motion, besides being simpler, effects a better distribution of the steam, in many respects, than the link-motion.

Amongst the most interesting features of the Exhibition were the refrigerating machines. Of these there were four, exhibited by Messrs. Bell-Coleman, Messrs. T. Pigott and Co., the Haslam Foundry and Engineering Company, and Messrs. J. and E. Hall. As we have so recently described the principle of action of these machines, it will not now be necessary to go into details. It may, however, be mentioned that they are at the present moment being used by the Peninsular and Oriental, the Cunard and the Orient Steam-ship Companies, and also by the London and St. Katharine Dock Company, and the Orange Slaughtering Company. The successful application of mechanical refrigeration to the preservation of fresh meat and other provisions, is a subject of such immense importance, that we are not surprised at the great interest excited by these machines.

Amongst the miscellaneous exhibits we can specially mention the numerous collapsible and other life-boats, and the boat-lowering apparatus, some of which are really admirable. Also the wire-rope rigging, and the stout wire torpedo nets, exhibited by Messrs. Bullivant and others.

It seems a pity, considering the great amount of interest which has been excited by this Exhibition, that it should only remain open for ten days.

TOTAL ECLIPSE OF MAY 17

WE have given from time to time, in the Astronomical Column, particulars of the approaching total eclipse, pointing out that it is visible at a point on the Nile, in lat. 26° 32′ N. We are glad to be able to state, that an expedition left this country yesterday with the view of obtaining photographic and spectroscopic observations. The expedition has been organised by the Science and Art Department and the Royal Society combined, on the recommendation of the Solar Physics Committee.

The expedition sails to Suez in the Peninsular and Oriental steamship *Kaisar-i-Hind*, and a good idea of the local arrangements made will be gathered from the accompanying article, which we reprint from the *Daily News* of yesterday :—

May 17, 7 a.m., sun eclipsed, visible at Greenwich. Thus runs the records in our pocket-books. So short,